Studies for High-Power Solid and Liquid Targets

There is a world-wide effort to design and implement proton driver beams in the multi-MW class which can provide the basis for producing powerful, intense secondary beams for use in future physics experiments. But first, significant technical challenges must be addressed before suitable proton beam targets can be installed to serve this purpose. These issues include 1) thermal management to address the huge heat loads encountered from the energy deposition of the interacting/showering proton beam, 2) radiation damage in which material properties are altered leading to a possible degradation of target performance, and 3) the generation of intense pressure waves which can lead to target break-up.

The BNL targetry program has been formed in response to these recognized problems. The program includes a study of possible candidate target materials with a wide range of atomic-Z numbers. This recognizes that different types of secondary beams have different optimal production characteristics. For example neutrino beams resulting from the decay of fast pions benefit from low-Z targets, $\bar{p}$ production is enhanced with targets in the mid-Z range, and muon production is optimal when copious soft pions are produced with high-Z targets.

Solid targets have been investigated with a focus on the survivability of the targets. Materials which are resistant to fracturing and break-up due to the generation of intense pressure waves are being sought. This program entails the irradiation of candidate materials in order to evaluate their properties after prolonged exposure to radiation.

The problems presented by solid targets being exposed to intense proton beams has lead to a consideration of the merits of utilizing liquid targets. The Muon Collaboration, in particular, has developed a scenario for the production of intense muon beams based on immersing a high-Z liquid material (either Hg or perhaps a Pb-Bi eutectic) within a high-field solenoid for the purpose of producing and capturing the soft pions generated when the proton beam interacts with the target. This effort includes a leadership role in the approved CERN experiment (nTOF11) to demonstrate the technical feasibility of a mercury jet target under conditions suitable for a Neutrino Factory. This work might also be applicable to Super-beams.

Program Request

M&S - Irradiation exposure, hot cell usage, measuring equipment - 750 k $
(M&S funds for the CERN experiment (nTOF11) are secured via the Muon Collaboration)

Staff -

3 x 150 k$ for one Post-Doc position and
3 x 50 k$ for support of one graduate student

Participating Institutions

- Solid Targets – BNL, SLAC, KEK, Princeton, Stony Brook
- Liquid Targets – BNL, CERN, KEK, Princeton, ORNL, RAL